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3 April 1970

Materiel Test Procedure 2-3-510
U. S. Army Armor and Engineer Board

AD871928

U. S. ARMY TEST AND EVALUATION COMMAND
COMMON SERVICE TEST PROCEDURE

INLAND WATERWAY OPERATIONS

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1. OBJECTIVE

The objective of this Materiel Test Procedure (MTP) is to outline general procedures for determining the floating and swimming capabilities of automotive type vehicles in inland waterways.

2. BACKGROUND

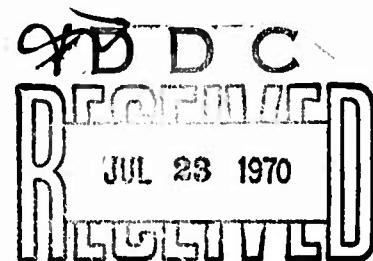
Mobility, communications, and effective firepower have always been the keys to offensive operations in warfare. Development of mechanized forces provided greatly increased speed and maneuverability in all areas except in crossing water barriers. In World War II mechanized combat and support vehicles moved swiftly cross-country on a broad front, but were channeled back onto the narrow established routes of travel afforded by bridges at every sizable water obstacle. This led to the requirements for shallow and deep fording and then to underwater fording, floating, and swimming. Water crossing ability is needed for all tactical vehicles if they are to have maximum mobility and independence from highways.

Swimming is defined as the ability of a vehicle to negotiate a water obstacle by propelling itself without being in contact with the bottom. The terms test vehicle and test item as used in this document include the trailer when applicable.

3. REQUIRED EQUIPMENT

- a. Suitable Water Obstacles.
- b. Slope Gage.
- c. Long Straight Edge.
- d. Anemometer.
- e. Sounding Line.
- f. Tape Measure.
- g. Life Preservers (one for each crew member).
- h. Buoys.
- i. Safety Boat with trained operators.
- j. Scuba Divers (at least two) with necessary equipment.
- k. Stop Watches.
- m. Ambulance with trained first aid man and resuscitator, if available.
- n. Aiming Circle and Stakes.
- o. Radios on control vehicle, safety boat, recovery vehicle/wrecker, and test vehicle.
- p. Recovery Vehicle or Wrecker (appropriate for recovery of equipment being tested).
- q. Life Rings.
- r. Types and Quantities of Cargo as required.
- s. On Equipment Materiel (OEM) as required.

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Aberdeen Proving Ground, Md. 21005

MTP 2-3-510
3 April 1970

- t. Cameras and Film as required.
- u. Applicable Technical Manuals.

4. REFERENCES

USATECOM Regulation 385-6, Verification of Safety of Materiel During Testing.

5. SCOPE

5.1 **SUMMARY**

This MTP outlines procedures for the following:

a. Preparation for test:

- 1) Initial safety precautions, training and evaluation of published instruction.
- 2) Orienting test personnel and arranging for required materiel and facilities.
- 3) Pretest inspection of test materiel by qualified mechanics and test personnel.
- 4) Selecting and reconnoitering test sites and making safety checks of selected test sites.

b. Test conduct:

- 1) Swimming in still and moving water with vehicle at minimum weight.
- 2) Swimming in still and moving water with vehicle at maximum weight.
- 3) Post swimming checks by crew and post swimming maintenance by qualified personnel.

5.2 **LIMITATIONS**

The procedures in this document are specifically for use with automotive type equipment.

6. PROCEDURES

6.1 **PREPARATION FOR TEST**

6.1.1 Safety

The project officer shall ensure that a Safety Release (paragraph 4, reference) has been received from HQ, USATECOM and is understood by all personnel prior to testing. A Safety Release includes information pertaining to operational limitations and specific hazards peculiar to the test item.

6.1.2 Personnel

MTP 2-3-510
3 April 1970

a. Selected well-trained personnel will be used for this test. In addition, all test personnel will be trained on the specific test item in accordance with pertinent technical manuals and other appropriate documents. Special emphasis should be placed on training covering safety during water operations and techniques and routes of escape from the vehicle if it should sink. Dry run evacuation exercises should be conducted until all test personnel are thoroughly familiar with the published procedures. Any discrepancies noted in these procedures should be recorded along with recommended changes.

b. Record the following for each test participant:

- 1) Name, rank or grade
- 2) Military occupational specialty (MOS)
- 3) Experience in MOS
- 4) Amount of training or experience in inland waterway operations

6.1.3 Orientation

The project officer should orient all test personnel on the objectives of the test, how the test is to be conducted, safety precautions to be taken, the data that must be generated and how it will be recorded.

6.1.4 Stowage/Cargo Load

a. Make arrangements for the required OEM and table of organization and equipment (TOE) and table of allowance (TA) items or acceptable substitutes for stowing vehicles. Substitute items should be as near the same configuration and weight as the original items as possible.

b. Obtain sufficient quantities and types of cargo to representatively load cargo vehicles and trailers.

6.1.5 Test Arrangements

a. Select suitable test sites and inland water operations scheduled just prior to scheduled maintenance services. Arrangements should be made to ensure that the required personnel and medical, safety, communication and recovery equipment, along with the other miscellaneous items listed in paragraph 3 above, are available and in proper operating condition at the test site.

b. Paint freeboard determining marks (graduated in inches) on the front and rear ends (near the corners) of each test vehicle and trailer when applicable.

6.1.6 Pretest Inspection

a. Subject the test vehicle (including trailer, when applicable) to a pretest inspection conducted by qualified maintenance personnel and test personnel trained on the test item and experienced in inland waterway operations. Maintenance inspection should include a verification of engine, transmission, steering, bilge pump and electrical system performance. A limited road test may be required.

- b. Clean bilge pump inlet screens and the surrounding area and verify proper pump performance by actual pumping, preferably into a container such as an empty drum so that an approximate rate of pumping can be established.
- c. Check oil and lubricants for proper levels and for signs of water.
- d. Make repairs or adjustments as required to place the vehicle in proper operating condition.
- e. Ensure that when vehicles are stowed and/or loaded that all OEM, TOE and TA items are present and in their proper place, and that the prescribed cargo is loaded and lashed for proper balance and to prevent shifting.
- f. Inspect all drain plugs to ensure that they are completely secured/closed. This should be done in conjunction with the check out of the bilge pump operation when the drain plugs are covered with water.
- g. Erect flotation barriers or other flotation devices and check for signs of wear and damage and stability of mountings.
- h. Determine and record the adverse effects of flotation equipment on the tactical land use of the vehicle.
- i. Record the following:
 - 1) Any difficulties encountered in preparing the vehicle for swimming.
 - 2) Inadequacies of published procedures.
 - 3) Recommendations for changes in preswim procedures.

NOTE: A sample check list for preswimming operation is attached as Appendix A.

6.1.7 Test Site Selection and Reconnaissance

- a. Perform site selection and reconnaissance including the selection of approach routes, possible entry and exit points as an underwater reconnaissance of the water area to be used.
- b. Determine the depth of the water throughout the areas to be traveled by using a sounding line or other depth measuring devices.
- c. Select several entry and exit points with varying degrees of slope to ensure that the vehicles maximum ingress and egress capability as well as that specified by the criteria can be evaluated. Measure and chart slopes to be negotiated and mark all underwater hazards such as tree stumps, sand bars or boulders with buoys if near the water lanes to be used.

NOTE: The lake or stream bottoms near the points of entry and exit should be fairly even. Uneven ground at water depths where the vehicle is almost buoyant may cause the vehicle to tilt and take water or even tip over.

- d. Mark intended lanes of travel with buoys. When selecting and marking crossing lanes and landing sites on moving streams, the velocity of the current must be known and considered to ensure that the landing approach will be made at the proper angle. If the vehicle does not approach the bank at the proper angle the current will turn it parallel to the bank as it attempts to exit.

- e. Select, measure and mark courses with buoys for use in deter-

mining the maximum speed of the test item in still and moving water.

6.1.8 Preswim Safety Check

a. Just prior to placing the vehicle in the water perform a final check to include safety measures, communications, and recovery plans and facilities.

b. Ensure the presence and readiness of the following:

- 1) Ambulance with trained first aid man and resuscitator.
- 2) Two qualified scuba divers with equipment.
- 3) Safety boat with trained operators and radio equipment.
- 4) One life preserver for each crew member.
- 5) Recovery vehicle/wrecker with crew trained in underwater recovery and with radio equipment.
- 6) Control vehicle with radio.
- 7) Radio for use in test vehicle, if not so equipped.

6.1.9 Communications

Upon completion of the pretest inspection and preswim safety check (paragraphs 6.1.6 and 6.1.8) and prior to performing swimming tests to establish radio communications between the test, control and recovery vehicles or wrecker, and the safety boat.

6.2 TEST CONDUCT

a. Conduct all swimming tests just prior to performing applicable scheduled preventive maintenance.

b. Initial swimming shall be done in still water and the entry shall be over a minimum slope.

6.2.1 Swimming - Vehicle at Minimum Weight

Determine the ability of the test vehicle to perform swimming operations, at minimum weight, using the following procedures:

a. During the initial entry into the water a tow cable from the recovery vehicle or wrecker shall be attached to the test item for retrieval purposes, if necessary.

b. On subsequent entries the test item must be equipped with 2 tow cables as follows:

- 1) One tow cable will be secured to a towing eye on each end of the vehicle.
- 2) The free end of each cable shall be tied on top of the vehicle in a readily accessible position for emergency recovery operations.
- 3) A flotation marker buoy shall be attached to the free end of each cable.

6.2.1.1 Swimming in Still Water

Determine the suitability of the test item for swimming in still water as follows:

a. Tactical vehicles shall be without stowed load and cargo vehicles and trailers, when appropriate, shall be without cargo.

b. No more than two men shall be in either type of vehicle.

c. During initial entry, with bilge pumps operating, move the test item slowly into the water until it becomes buoyant, and perform the following:

- 1) Thoroughly inspect the test item while it is being eased into the water for leaks.
- 2) Report the location of any leaks to the control officer by radio with an indication of their severity (minor, moderate, serious) and whether the bilge pumps are performing adequately. If serious leaks occur, the vehicle shall return (towed if necessary) to land for repairs.
- 3) After initial entry, if no leaks occur or leaks are insignificant, return the test item to land and disconnect the recovery tow cable.

d. Operate the vehicle on a straight course from land into the water, stop the vehicle in the water and allow it to float.

e. Restart the vehicle, proceed on a straight course then circle in wide turns to the right and left at full speed followed by gradually tighter turns reducing speed as required. Determine and record the minimum turning radius, both left and right, at full speed and at the reduced speeds.

f. Subject the test item to rapid acceleration and deceleration, observing and recording vehicle attitude, freeboard (front and rear) and time required for each operator as follows:

- 1) With the vehicle at stop, accelerate it to maximum speed in both the forward and reverse directions.
- 2) With the vehicle going at maximum speed, in straight direction, decelerate to stop in both forward and reverse direction.

g. Operate the vehicle out of and into the water at the preselected points with varying percentages of slope until the maximum negotiable entry and exit slopes are determined.

NOTE: The maximum exit slope is not always determined by loss of traction, in some cases the deciding factor may be water entering into the rear of the vehicle. The slope of the ground underneath the water near the shoreline may also be a determining factor, that is, the greater the angle of slope the deeper the water and the greater the probability that water will enter into the rear of the vehicle. The most suitable speed of entry into the water will be dependent upon such factors as vehicle design, angle of entry slope, size of payload, etc.

h. During procedures of steps d. through g., personnel on shore shall observe and record the attitude of the vehicle in the water and the apparent adequacy of freeboard.

i. Using the measured course, operate the test vehicle at maximum speed in both directions over the course and record the time required for each run.

j. Photograph the test vehicle while floating and swimming at various speeds and as needed to show other aspects of testing.

k. Record the following, as applicable:

- 1) Model, serial number, and test number of vehicle.
- 2) Type of propulsion and/or steering provided.
- 3) Date and time of test.
- 4) General description of the body of water in which testing is being conducted.
- 5) Weather conditions including direction and velocity of wind.
- 6) Percent of entry slopes and types and conditions of soil.
- 7) Water depth at which vehicle becomes buoyant.
- 8) Location and degree of severity of all leaks detected.
- 9) Adequacy of bilge pumps.
- 10) Attitude and freeboard (front and rear) of vehicle while floating.
- 11) Attitude and freeboard (front and rear) of vehicle while moving on straight course at various speeds.
- 12) Attitude and freeboard (front and rear) of vehicle while turning at various speeds.
- 13) Any difficulties or peculiarities noted in steering.
- 14) Speed of vehicle when entering water to include optimum speed for water entry if determined.
- 15) Difficulties encountered during entry, if any.
- 16) Maximum water speed obtained.
- 17) Adequacy of surfboard, trim vane, etc., if applicable.
- 18) Adequacy of flotation envelope or other flotation equipment.
- 19) Percent of exit slopes, type and condition of soil.
- 20) Obstructions to driver vision, if any.
- 21) Difficulties encountered during exit, if any.
- 22) Height of waves, if any, and wind conditions.

6.2.1.2 Swimming in Moving Water

a. Upon completion of operations in still water, determine the swimming characteristics of the test item in moving water by repeating steps d. through k. of paragraph 6.2.1.1, preferably in a navigable stream where there is sufficient current and waves to test the capability of the vehicle.

NOTE: If this does not follow immediately after test outlined in paragraph 6.2.1.1, it should be preceded by the pretest inspection, preswim safety check, and the initial precautioning water entry as outlined in paragraphs 6.1.6, 6.1.8, and steps a. through c. of paragraph 6.2.1.1, respectively.

b. Record the data as described in step k of paragraph 6.2.1.1, and the following:

- 1) Velocity of current and direction in relation to entry and exit of the test item.
- 2) Maximum water speed obtained while moving with and against the current.

6.2.2 Swimming - Vehicle at Maximum Prescribed Weight

Determine the suitability of the test item for swimming at maximum prescribed weight using the following procedures:

- a. Unless previously established, the test item shall be weighed and the weight recorded.
- b. Weigh and record the weight of the stowed loads of step c and personnel of step d to ensure that the maximum gross vehicle weight for swimming is not exceeded.
- c. Stow all vehicles with the prescribed OEM, TOE and TA items or acceptable substitutes and load cargo vehicles with a prescribed load of cargo.

NOTE: Use the prescribed stowage or acceptable substitute and actual cargo loads in order to determine the load balance along with the test item's swimming capacity.

- d. Normal complement of personnel shall be on combat and cargo vehicles.
- e. For the initial maximum load buoyancy test of personnel carriers, appropriately spaced weights should be substituted for the personnel for safety reasons. Thereafter, the normal complement of personnel shall be used.
- f. The initial maximum load swimming of all vehicles shall be done in still water.

6.2.2.1 Swimming in Still Water

With the test item loaded as described in steps c. and d. or e. determine its swimming capability as follows:

- a. Observe the safety precautions, perform the operational procedures, maneuverability exercised, maximum speed trials and acceleration and deceleration procedures of steps d through j of paragraph 6.2.1.1.
- b. Record the data required in step k of paragraph 6.2.1.1, and the following, if required:

- 1) Description of any accidental shifting of cargo.
- 2) Changing of loads or repositioning of personnel to provide better vehicle balance.
- 3) Adequacy of cargo tie-down facilities and materials.

MTP 2-3-510
3 April 1970

6.2.2.2 Swimming in Moving Water

Determine the suitability of the test item for swimming in moving water by performing the procedures described in paragraph 6.2.1.2, and recording the following:

- a. Data required by paragraph 6.2.1.2.
- b. Description of any accidental shifting of cargo.
- c. Changing of loads or repositioning of personnel to provide better vehicle balance.
- d. Adequacy of cargo tie-down facilities and materials.

6.2.3 Post Swimming Check

a. Perform the following each time the test vehicle is driven from the water:

- 1) Apply brakes and record their effectiveness.
- 2) Operate the test vehicle, with flotation devices in swimming position, over the various soils encountered, and record suitability of the test item's overall performance and the effect of the flotation devices on the performance.

b. At the completion of testing return the test item to land use condition, including returning the flotation devices to their preswimming location or condition and record the following:

- 1) Difficulty encountered returning flotation devices to pre-swimming conditions.
- 2) Time required to return the vehicle to proper land use condition.
- 3) Adequacy of instructions on:
 - a) Using flotation equipment
 - b) Covering test item water operations
- 4) Effectiveness of flotation devices for swimming.

6.2.4 Post Swimming Maintenance

Conduct a post swimming inspection of the test item and perform all applicable scheduled preventative maintenance services, as outlined in the pertinent technical manual(s) for the test item immediately following water operations, and record the following:

- a. Any water found in oils or lubricants or components that are supposed to be sealed or otherwise protected from water.

b. Any damage or deterioration to vehicle components due to water operations.

c. Adequacy of test item publications as pertains to past swimming maintenance functions, if applicable.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Safety

Record the following:

a. Operational limitations or hazards peculiar to swimming the test item as provided in the Safety Release.

b. Adequacy of instructions covering safety.

c. Type and amount of special training given to personnel.

d. Adequacy of hatches, etc., for emergency evacuation.

6.3.1.2 Personnel

Record the following for each test participant:

a. Name, rank or grade.

b. Military occupational specialty (MOS).

c. Experience in MOS.

d. Type and amount of training required if any and experience in inland waterway operations.

6.3.1.3 Pretest Inspection

a. Record the following:

1) Repairs, adjustments or servicing required.

2) Pumping capacity of bilge pumps in gpm.

3) Difficulties encountered preparing the test item for swimming.

4) Adequacy of instructions for preparing vehicle for swimming.

5) Adverse effect of flotation equipment on tactical land use of the vehicle.

6) Recommendations for improving preswim procedures.

b. Retain completed checklists

6.3.2 Test Conduct

6.3.2.1 Swimming

Record the following, as applicable:

a. Water condition (still, moving).

MTP 2-3-510
3 April 1970

- b. Vehicle condition (minimum weight, maximum weight).
- c. Model, serial number, and test number of vehicle.
- d. Type of propulsion and/or steering provided.
- e. Date and time of test.
- f. General description of the body of water in which testing is being conducted.
- g. Weather conditions including direction and velocity of wind.
- h. Percent of entry slopes and types and conditions of soil.
- i. Location and degree of severity of all leaks detected.
- j. Adequacy of bilge pumps.
- k. Attitude and freeboard (front and rear) of vehicle while floating.
- l. Attitude and freeboard (front and rear) of vehicle while moving on straight course at various speeds.
- m. Attitude and freeboard (front and rear) of vehicle while turning at various speeds.
- n. Any difficulties or peculiarities noted in steering.
- o. Speed of vehicle when entering water to include optimum speed for water entry if determined.
- p. Difficulties encountered during entry, if any.
- q. Adequacy of surfboard, trim vane, etc., if applicable.
- r. Adequacy of flotation envelope or other flotation equipment.
- s. Percent of exit slopes, type and condition of soil.
- t. Obstructions to driver vision, if any.
- u. Difficulties encountered during exit, if any.
- v. Height of waves, if any, and wind conditions.
- w. For still water tests (minimum and maximum load) only:
 - 1) Maximum water speed obtained
 - 2) Water depth at which vehicle becomes stable
- x. For moving water tests (minimum and maximum load) only:
 - 1) Velocity of current in mph
 - 2) Director of current in relation to:
 - a) Vehicle entry
 - b) Vehicle exit
 - 3) Maximum water speed obtained in mph:
 - a) Moving with current
 - b) Moving against current
- y. For maximum loaded vehicles only:
 - 1) Type of vehicle load in pounds
 - 2) Weight of vehicle load in pounds
 - 3) Cargo weight in pounds
 - 4) Total weight of personnel in pounds
 - 5) Description of any accidental shifting of cargo

- 6) Changes of loads or repositioning of personnel
- 7) Adequacy of cargo tie-down facilities and materials

6.3.2.2 Post Swimming Check

Record the following:

- a. Effect of water on brake effectiveness.
- b. Effect of water on vehicle overall effectiveness.
- c. Effect of flotation device on vehicle land use.
- d. Difficulty encountered returning flotation device to preswim condition.
- e. Time, in minutes, to return vehicle to proper land use condition.
- f. Adequacy of instructions:
 - 1) For using flotation equipment
 - 2) Covering test item water operations
- g. Effectiveness of flotation devices for swimming.

6.3.2.3 Post Swimming Maintenance

Record the following:

- a. Any water found in oils or lubricants or components that are supposed to be sealed or otherwise protected from water.
- b. Any damage or deterioration to vehicle components due to water operations.
- c. Adequacy of test item publications as pertains to post swimming maintenance functions, if applicable.

6.4 DATA REDUCTION AND PRESENTATION

All data obtained by inspection and testing described in this MTP, including photographic coverage, should be suitably tabulated or otherwise arranged for correlation under the appropriate subtest within the report of test and presented in a manner to indicate whether the test item meets the Qualitative Materiel Requirement, or other applicable criteria.

APPENDIX A

SAMPLE PRESWIMMING CHECK LIST FOR INLAND WATERWAY OPERATIONS*

1. Check engine and transmission for proper operation.
2. Check main engine crankcase oil level.
3. Check transmission oil level.
4. Check oil levels in winch gear case and hydraulic reservoir.
5. Check driver's controls and instruments.
6. Check all lights.
7. Check radio and intercom.
8. Check stowage of on equipment materiel.
9. Check cargo for quantity (weight) and loading for balance and lashing.
10. Check track for proper adjustment.
11. Check to ensure drain plugs are secured and/or drain valve closed.
12. Check bilge pump to ensure it is operational and intake screen is clean.
13. Check life jackets (one per person).
14. Check emergency tow cables, should be rigged front and back, with free ends secured on top of vehicle and a marker buoy attached to each of the tie ends.
15. Check operators for knowledge of emergency hand signals.
16. Check for emergency rescue and recovery support (cable from recovery vehicle attached to test item, if applicable).
17. Check operators for knowledge of swimming operation to be accomplished.
18. Start engine and check for full performance prior to swimming.
19. Check steering system for full performance prior to swimming.
20. Check flotation equipment for serviceability and mounting.
21. Check surfboard, trim vanes, etc., for serviceability and mounting.

*List covers personnel carriers, combat vehicles and cargo vehicles, and applicable trailers.

MTP 2-3-510
3 April 1970

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| 11 SUPPLEMENTARY NOTES ----- | | 12 SPONSORING MILITARY ACTIVITY Headquarters US Army Test and Evaluation Command Aberdeen Proving Ground, Maryland 21005 |
| 13 ABSTRACT This Army Service Test Procedure describes test methods and techniques for evaluating the performance and characteristics of Automotive Type Vehicles in Inland Waterways with regard to Floating and Swimming Capabilities, and for determining their suitability for service use by the U. S. Army. The evaluation is related to criteria expressed in applicable Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), Technical Characteristics (TC), or other appropriate design requirements and specifications. | | |

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